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Date: 28 September 1962

286 280

EFFECTS OF PLASTIC DEFORMATION ON TENSILE TEST SPECIMENS BY VARIATIONS IN THE STRAINING RATE



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GENERAL DYNAMICS | FORT WORTH

A DIVISION OF GENERAL DYNAMICS CORPORATION

(FORT WORTH)

TEST-6866

MODEL Engineering Research



DATE 3 Jan. 1958

11

TITLE

EFFECTS OF PLASTIC DEFORMATION ON

TENSILE TEST SPECIMENS BY VARIATIONS IN THE STRAINING RATE

SUBMITTED UNDER

ENGINEERING RESEARCH: W. O. No. 14-05-641

The tests described in this report were conducted between October and December 1957.

PREPARED BY: S. V. Glorioso	GROUP: METALLURGICAL Engineering Test Lab.
CHECKED BY: Sattings. C. Batterger	APPROVED BY: J. M. Clark
NO. OF PAGES	J. F. Robinson
PRVISIONS	·

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C O N V A I R

A DIVISION OF GENERAL DYNAMICS CORPORATION (FORT WORTH)

REPORT NO. FGT-1824 MODEL Eng. Research DATE 3 Jan. 1958

EFFECTS OF PLASTIC DEFORMATION ON

TENSILE TEST SPECIMENS BY VARIATIONS IN THE STRAINING RATE

PURPOSE:

The purpose of this investigation was to establish a maximum strain rate for performing tensile tests on metallic materials in the plastic range.

SUMMARY:

The effect of strain rate in the plastic range on the percent elongation, percent reduction of area, and the rise in specimen temperature due to straining 5052-0 aluminum alloy, AZ80A magnesium alloy and annealed SAE 4130 steel was determined.

Eleven specimens of SAE 4130 steel which were heat treated to approximately 200,000 psi were also tensile tested at various strain rates to determine how the rise in temperature due to straining compared with the annealed SAE 4130 steel specimens.

It was found that strain rate in the plastic range had no significant effect on the percent elongation or percent reduction of area properties of the materials tested. The increase in temperature due to increased strain rates was greater for the SAE 4130 steel heat treated to 200,000 psi than for the annealed 4130 steel, but in neither case did it significantly affect the percent elongation or percent reduction of area properties.

A DIVISION OF GENERAL DYNAMICS CORPORATION

(FORT WORTH)

REPORT NO. FGT-1824
MODEL Eng. Research
DATE 3 Jan. 1958

EFFECTS OF PLASTIC DEFORMATION ON

TENSILE TEST SPECIMENS BY VARIATIONS IN THE STRAINING RATE

OBJECT:

The object of this test was to determine the effect of strain rate in a standard tension test on specimen temperature and the elongation and reduction of area properties of 5052-0 aluminum alloy, AZ80A magnesium alloy and SAE 4130 steel in the annealed and heat treated conditions.

PROCEDURE:

Standard 0.505 in. diameter tensile specimens*were fabricated from 5052-0 aluminum alloy, AZ80A magnesium alloy and anealed SAE 4130 steel. Additional specimens were also prepared using SAE 4130 steel heat treated to approximately 200,000 psi. All specimens were marked to retain their identity as follows:

MATERIAL	SPECIMEN	NUMBER
5052-0 SAE 4130, annealed AZ80A SAE 4130, heat treated	A-1 thru B-1 thru C-1 thru D-1 thru	B-20 C-18

Tension tests were performed on a 120,000 lb. Baldwin universal testing machine which was equipped with an MA-1 microformer recorder and a Peter's strain pacer. All specimens were tensile tested using a strain rate of .005 in/in per minute for the elastic range. After the yield point at .2% offset was reached the strain rate was increased to a predetermined value until failure occurred. Various strain rates were used in the plastic range to determine their effect on the ductility of each of the materials tested.

The increase in specimen temperature due to straining was measured with a thermocouple which was manually held in contact with the necked down portion of each specimen.

Since the Peter's strain pacer was used on each specimen until failure occurred, it was necessary to use an extensometer with a range of at least one inch. A Baldwin model KSM extensometer was used for strain rates from 0.0125 in/in per minute up to and including 0.25 in/in per minute, and a model PS8M was used for all other strain rates.

* Specimen Type R1, Method 211, Federal Test Method Std. No. 151

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The amount of time required for failure to occur after 0.2% offset yield was obtained was from 3 to 8 seconds for the fastest strain rates used for the different materials, and from 8 to 23 minutes for the slowest rates used.

RESULTS:

Results are shown in Tables I, II, III and IV, and graphically in Figures 1, 2, 3 and 4. Photographs of two of the failed specimens of 4130 steel which were heat treated to approximately 200,000 psi are shown in Figure 5.

DISCUSSION:

Ultimate strength, yield strength, percent elongation, percent reduction of area and the rise in specimen temperature due to straining are shown for various strain rates in Tables I, II, III and IV.

The effect of strain rate on percent elongation, percent reduction of area, and the rise in specimen temperature due to straining for each material are shown in Figures 1, 2, 3 and 4.

The 4130 steel which was heat treated to approximately 200,000 psi exhibited two different types of fractures; one a rosette type fracture at slow strain rates of 0.25 in/in per minute and slower, and the other a cup and cone type fracture at faster rates. A photograph of these two type failures is shown in Figure 5.

CONCLUSIONS:

The rate of straining has no significant effect on the percent elongation or percent reduction of area properties of 5052-0 aluminum alloy, annealed SAE 4130 steel or AZ80A magnesium alloy when these materials are tensile tested using standard procedures.

The increase in temperature due to straining was higher for SAE 4130 steel heat treated to approximately 200,000 psi than for annealed 4130 steel, but in neither case did it significantly affect the percent elongation or the percent reduction of area properties.

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Page 5 FGT-1824

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CONVAIR -- FORT WORTH

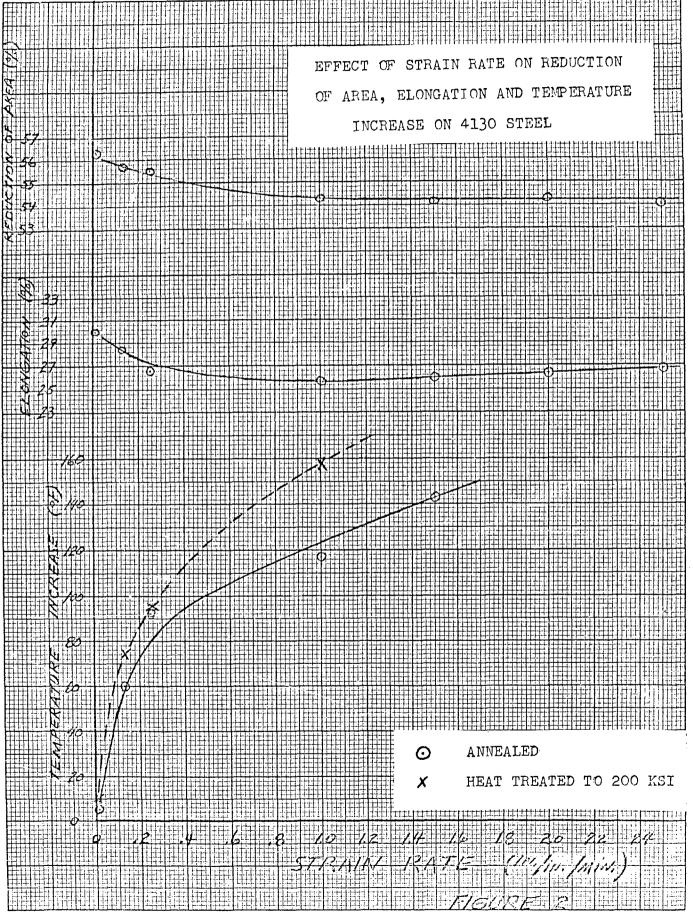
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